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COMMERCIAL RECIRCULATING TROUT HATCHERIES OF SASKATCHEWAN: HISTORY AND DEVELOPMENT 1979-1985

by

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ABSTRACT: Trout farming in Saskatchewan has been in place since about 1970, with spring planting in ponds and gill net recovery in the fall. Development of the first private commercial recirculating trout hatchery at Floral, Saskatchewan, to the five large hatcheries now in operation, is largely a result of entrepreneurial fish culture. Since simple tank and filter systems were first utilized, spin-off industries are now a support to the fish culturist. What was at one time considered to be a high-risk operation has now been stabilized by research into water quality, temperature regulation and systems design for maximum health and growth. New developments in brood stock programs for trout and char make the future look promising for independent business.

History

Interest in trout farming began in 1970 in Saskatchewan. All trout fingerlings were imported from South Dakota and Wisconsin. A and B Trout Farms began extensive trout farming in 1974, and until 1979, they harvested 10-12 oz. (284-340 g) fish. Under-sized fish represented 35-40% of the harvest. This was primarily due to ungraded fingerlings purchased from distributors. Orders of 3.5 inch (8.9 cm) fingerlings were sent out as 2-4 inch (5-10 cm). These factors and the recognition of a new aquaculture potential for Saskatchewan led to a consideration of a trout hatchery in the province.

In 1977, A and B Trout Farms designed a recirculating trout hatchery. In April of 1979 an investigation into the operation of Federal and Provincial recirculating and single-pass hatcheries in Canada and a number of American Federal, State, and private hatcheries was carried out (1). Feed and egg suppliers were also visited. Ideas obtained in these visits were incorporated in the plan.

In December of 1979 the first recirculating hatchery in Saskatchewan was opened (2). This consisted of two rearing tanks and two troughs operating from one biological filter. A simple de-iron filter was assembled to reduce iron from 10 ppm to 0.09 ppm. Water hardness was 1208, pH 7.6, and all other parameters were consistent with two single-pass hatcheries previously visited. The volume of water taken from the well was 5 gpm (22.7 L) on demand. Make-up requirements were 300 cc/minute to each tank or trough.

Eggs from Mt. Lassen's Hildebrand strain were obtained with the help of the Freshwater Institute in Winnipeg. A great deal of encour-

agement was given to A and B Trout Farm from the Freshwater Institute. They supplied the eggs and some feed to get this venture off the ground.

On January 10, 1980, 40,000 eggs were placed in baskets in troughs. Hatching was completed by January 20th. Silver Cup feed was used the first year, with additional feed coming from the Saskatchewan Fort Qu'Appelle Hatchery. Some losses were incurred due to an aeromonas infection that was stopped with Tetramycin incorporated in the water. No filter problems were encountered. Experiments with maximum and minimum oxygen levels reduced the fish population to 28,000. By May 17th, 3.75 inch (9.5 cm) fingerlings were sold to fish farmers, and 20,000 were planted in A and B Trout Farms' 45 acre (18 ha) lake. Total feed consumed in the hatchery was 263 lbs. (119 kg). Water temperature was 13.9^{o}C and the average oxygen was 5.7 ppm. The planting of 20,000 fingerlings resulted in only 6% under-sized trout in the fall harvest. This reduction of under-sized trout was due primarily to the implementation of grading the fingerlings at specific times during rearing period in the hatchery.

With some modifications to the biological filters and the iron filter, 50,000 fingerlings were produced in 1980-1981, and 100,000 fingerlings were produced in 1981-1982 under the name of The Aquaculture Centre. No hatchery was in operation in the 1982-1983 season in Saskatchewan. The author then developed a recirculating system which became a prototype to five private hatcheries in Saskatchewan and which now serves as a research and demonstration model at the Saskatchewan Research Council. This hatchery development came from Takara Trout Hatchery in 1983.

Development

The first rearing tanks used in recirculating units in Saskatchewan were vinyl lined pool tanks (3). Today, fiberglass units 7.5' x 7.5' x 2' (2.29 m x 2.29 m x 0.6 m) are now available off-the-shelf in Saskatoon at a price of $350.00. These tanks use 1' of water (30.5 cm) to carry 270 lbs. (122.5 kg) of 4" (10.2 cm) rainbow trout. This is a density of 4.8 lb./cu.ft. (169.5 kg/cu. m). A maximum water exchange rate of 5/hr., amounts to 29 gpm (132 L/min).

The biological filter is a fiberglass unit 7.5' x 7.5' x 1.83' (2.29 m x 2.29 m x 57 cm) which is also available locally for $350.00. This unit has 14" (35.6 cm) of 0.5" to 0.75" (1.2 cm - 1.9 cm) crushed rock as the filter medium, and an intake manifold. A Monarch BE33 or BE50 pump is used to circulate the water. Pinch-off valves are used on the discharge side of the pump to control water flow.

Aeration

Spray bars are presently used in Saskatchewan where all hatcheries use gas tensionometers to check saturation levels. Table 1 indicates gas saturation levels of a typical hatchery start-up. The gas saturometer indicates the problems that must be corrected before the introduction of eggs or fry.

In 1981 the Aquaculture Centre lost 50,000 eggs and sac fry in 11 days due to nitrogen gas bubble disease. No gas saturometers were available then to indicate lethal levels. The publication of a saturometer designed by Bouck in 1982 enabled Saskatchewan Research Council to build a unit in 1984 (4). It has since been commercialized by the

GASOMETER MEASUREMENTS IN SAKATCHEWAN RECIRCULATING HATCHERIES AT START-UP

STATION	TANK	TEMP. C	OXYGEN	ΔP	TOTAL GAS %	N2 %
Riverbend	1	13.75	10.0	16	102.2	106.5
	2	14.0	9.9	10	101.4	105.5
	3	14.0	9.9	4	100.6	104.4
	4	13.9	9.7	3	100.4	104.8
	5	13.9	9.7	3	100.4	104.8
	6	13.3	9.7	5	100.7	105.4
	7	13.8	9.7	4	100.6	105.1
	8	13.1	9.9	5	100.7	104.9
	9	13.1	9.9	3.5	100.5	104.6
	10	13.9	9.7	3	100.4	104.8
	11	13.9	9.7	4	100.6	105.0
	12	13.9	9.7	4	100.6	105.0
	WELL	8.0	2.2	60	108.4	132.0

Riverbend Trout Hatchery before Start-up Nov./84. Tank 1 & 2 were corrected before egg placement. Patm=714

STATION	TANK	TEMP. C	OXYGEN	ΔP	TOTAL GAS %	N2 %
F-P AQUA	A1	14.0	9.8	4	102.6	105.2
FARM	A2	13.2	9.9	4	102.2	105.0
	B1	14.5	9.8	4	102.7	105.1
	B2	13.5	10.0	3	101.1	104.7
	C1	14.4	9.8	4	101.7	105.0
	C2	14.4	9.8	3.5	101.6	104.9
	WELL	10.0	4.5	94.0	112.9	135.3

F-P Aquafarms Trout Hatchery before Start-up Nov./84 Patm=729

STATION	TANK	TEMP. C	OXYGEN	ΔP	TOTAL GAS %	N2 %
McNABB	1	11.0	10.2	28	103.9	108.9
	2	12.0	10.4	54	107.5	109.1
	3	12.0	10.4	67	109.4	111.3
	4	11.9	10.0	3	100.6	100.9
	5	12.0	10.2	40	105.6	107.0
	6	12.0	10.0	14	101.9	106.6
	7	12.0	10.4	63	108.8	110.6
	8	12.1	10.2	27	103.7	104.6
	9	11.3	10.7	80	111.2	113.3
	10	12.0	10.35	32	104.5	105.2
	WELL	7.0	1.0	100.0	114.0	142.1

McNabb Trout Hatchery before start-up Dec./84. All tanks except No.4 were corrected before egg placement. Patm=714

Table 1

author with changes and adaptations for Saskatchewan needs. The spade aeration unit strips nitrogen and carbon dioxide out but does not aerate as well as spray bars. The bars do not seem to remove excess nitrogen easily but oxygen levels are very satisfactory. Make-up water in each unit is 300 cc/min.

Filters

The biological filters perform well as long as pre-screening baskets are used to remove about 90% of fecal and waste food before it enters the rock medium. Daily cleaning of these basket screens is required. Back-washing is done once every four days when tanks are loaded in the area of 270 lbs. (122.5 kg) of 4" (10.2 cm) trout. In management comparison, the Saskatchewan Research Council Research Hatchery back-washes once every seven days with excellent filter water clarity. Each back-wash uses approximately 250 gal. (1136 L) of water in a 15 min. period from a 1,000 gal. (45,546 L) reserve tank provided for each five rearing units. This water has been aerated and de-ironed before entering the holding tank. Some hatcheries uses u.v. treatment after the de-iron process as another step to ensure pathogen-free water.

Biological activity in the first hatchery filters was generated from natural levels in the gravel. This is a slow process and must be watched very carefully or ammonia and nitrite levels can cause serious problems to eggs and fry if units are loaded too quickly. We have found that ammonia levels can be high even before fish or eggs are introduced to a new system. Table 2 shows start-up of a cleaned unit that had been operating for several weeks.

WATER QUALITY IN NEW SYSTEMS
AT START-UP TO INTRODUCTION
OF EGGS OR FRY

TANK		TEMP. C	OXYGEN ppm	N ppm	NITRITE ppm	pH	CO 2	ABA cc	DATE
1		10.8	10.3	.6	.04	8.0	10		day19
3		10.1	10.4	.5	.02	8.0	8.6		day19
1		11.3	10.3	.5	.08	8.0	9.0		day20
3		10.4	10.3	.4	.02	7.9	9.0		day20
1		11.5	10.0	.3	.08	7.8			day21
3		11.3	10.0	.4	.03	7.8			day21
1		8.9	10.4	.4	1.0	7.6		300	day22
3		7.8	10.5	.3	.05	7.6			day22
1		9.1	8.9	.3	.15	7.6			day23
3		8.1	9.8	.42	.03	7.3		300	day23
1		9.2	9.5	.3	.04	7.25			day24
3		8.2	10.6	.3	.02	7.28			day24
1		9.0	9.9	.1	.02	6.8			day25
3		8.2	11.2	.1	.02	6.6			day25
1	*	9.0	9.7	.1	.01	6.8			day26
3	*	8.1	11.0	.1	.01	6.8			day26
1		9.3	10.4	.1	.01	7.0			day27
3		9.0	10.6	.1	.01	7.0			day27
1		9.1	10.4	.1	.01	7.0			day28
3		8.5	11.1	.1	.01	6.9			day28

* - Denotes Arctic Char eggs in place from this day on.
N - Total Ammonia/Nitrogen. Nitrite - Total Nitrite/Nitrogen. ABA - Cultured Bacteria for Biofilters. CO2 - in ppm.

Table 2

The ammonia-nitrite levels can be reduced and stabilized by adding cultured bacteria. When new units are placed into operation for the first time, residual toxicities from tanks, etc. appear to restrict the orderly build-up of nitrosomonas and nitrobacter populations in the filter.

Second year operations do not present any ammonia-nitrite initial build-ups because bacteria have remained in the filter. Consequently loss of eggs, fry or fingerlings are considerably reduced. Average total ammonia levels range from 0.2 - 0.8 ppm at pH values from 8.2 - 7.3 in fingerling production. In brood stock systems total ammonia averages 0.35 - 0.4 ppm at pH values of 7.0 - 6.5. Low pH is due to high carbon dioxide levels from much larger fish. pH fluctuations are controlled with oyster shells and sodium carbonate. Table 3 shows typical values in rainbow trout brood stock tanks and arctic char incubation tanks in a recirculating hatchery.

Building and Waste Heat

The building for a recirculating hatchery must conserve as much heat as possible during our Saskatchewan winters. Good insulation, vapor barrier, paint, and a safe water disposal is important. Single-phase 220 volt power is required to operate the fractional circulation pumps. All hatcheries use well water that is very hard (alkaline with varying amounts of iron). No additional heating is used to heat the water. The waste heat from the circulating pump on each tank is sufficient for the building temperature maintenance. Table 4 shows an example for December and January of 1983-1984 of outside temperatures ver-

WATER QUALITY IN TROUT
RECIRCULATING HATCHERY

TANK	DATE	N TOTAL ppm	NITRITE TOTAL ppm		pH	TEMP. C	OXYGEN ppm	FISH TYPE
1	11/20/85	.5	.08		8.0	11.0	10.3	none
2	11/20/85	.1	.01		6.5	11.4	9.8	Brood
3	11/20/85	.5	.02		8.0	10.4	10.3	none
4	11/20/85				6.3	11.8	7.4	Brood
5	11/20/85				6.3	12.3	9.0	Brood
1	11/24/85	.3	.04		7.3	9.2	9.5	none
2	11/24/85	.25	.02		6.9	10.8	9.8	Brood
3	11/24/85	.3	.02		7.28	8.2	10.6	none
4	11/24/85	.2	.03		6.8	10.8	8.4	Brood
5	11/24/85	.2	.01		7.1	10.4	9.4	Brood
1	11/30/85	.2	.02		7.6	9.2	9.4	Char
2	11/30/85	.2	.01		7.3	10.4	9.6	Brood
3	11/30/85	.2	.01		7.4	8.3	10.0	Char
4	11/30/85				6.9	10.3	8.0	Brood
5	11/30/85				7.3	10.2	9.1	Brood
1	12/09/85	2.6	.02	*	6.8	9.4	10.2	Char
2	12/09/85	.4	.02		6.7	10.9	9.9	Brood
3	12/09/85	3.0	.02	*	7.0	8.2	11.2	Char
4	12/09/85	.4	.05		6.4	10.7	8.1	Brood
5	12/09/85	.3	.02		6.6	10.7	9.5	Brood
1	12/13/85	.4		*	7.45	8.7	10.6	Char
2	12/13/85	.4			6.8	10.0	10.6	Brood
3	12/13/85	.5		*	7.4	8.0	11.9	Char
4	12/13/85	.4			6.8	9.8	9.9	Brood
5	12/13/85	.5			6.8	9.6	10.4	Brood
1	12/25/85	.4		#	7.1	8.6	10.6	Char
2	12/25/85	.3			6.7	9.8	11.1	Brood
3	12/25/85	.3		#	7.0	7.4	10.2	Char
4	12/25/85	.28			6.6	9.9	8.7	Brood
5	12/25/85	.35			6.8	9.9	9.9	Brood

* - denotes eggs hatching. N - Toatal Ammonia/nitrogen. Nitrite - Total nitrite/nitrogen.
# - hatching complete. Data - Saskatchewan Research Council Aquaculture Field Lab.

Table 3

TEMPERATURE VALUES OF
HATCHERY TANKS VS
OUTSIDE DURING WINTER
OPERATIONS

DATE	TANK TEMP. C	OXYGEN	OUTSIDE TEMP. C
Dec.13/83	12.0	10.0	-20
15/83	12.4	10.0	-30
19/83	13.2	9.7	-33
21/83	12.8	9.8	-40
23/83	12.8	9.8	-42
25/83	12.9	9.4	-12
28/83	13.2	9.4	-18
31/83	13.1	9.4	-14
Jan. 3/84	12.5	9.6	+05
5/84	12.4	9.6	+05
9/84	12.5	9.2	-23
12/84	11.7	9.3	-18
16/84	12.5	8.6	-24
23/84	12.0	8.6	0
26/84	12.2	7.6	-20
28/84	12.0	7.3	+04
31/84	11.9	7.4	-02

From data at Takara Trout Hatchery 1983-84 50,000 R.B.T. operation. Building had R20 walls, R20 ceiling, incoming water supply was 5.5 C. No additional heating supplied, only the use of waste heat from circulating pumps is used. Ventilator controlled thermostatically for cooling and de-humidifying.

Table 4

sus water temperatures in a recirculating hatchery. The ambient heat in the building heats the water to the desired level.

Feed

Trout feed used in recirculating hatcheries has produced some interesting observations. In 1981-1982 the Aquaculture Centre tested three types of feed: Silver Cup, Rangen, and Martins. There was no difference in growth of trout from 2" to 3" (5 cm to 7.6 cm) though the two U.S. feeds (Silver Cup and Rangen) clouded the water to some degree. In 1984 Takara Trout Hatchery started with Rangen feed and had to change to Martin's feed due to severe reduced clarity of the water. As soon as the change was made to Martin's feed, mortality that had been higher than normal dropped to practically zero and cloudiness ceased in all tanks. In 1985 the first three large commercial hatcheries used Silver Cup feed. Water was cloudy (5). In 1986 operations all hatcheries used Martin's feed and have clearer water.

Fish Health

Most disease problems have come from the practice of over-feeding. Feed conversions of 0.65 - 0.75:1 are normal in recirculating units with the use of 24 hour lighting (7). Constant fluorescent lighting was first implemented by A and B Trout Farms more by accident than by planning. The departure from daylight hours has proved a benefit by promoting growth and reducing feed costs. Fungus, septicemia, and bacterial gill disease are controlled by either formaldehyde, Novatetra, salt, or Hyamine 3500. Ovidine is used in egg treatment. Bentadine is

used as an equipment and instrument disinfectant to prevent cross contamination from one unit to another.

Education

The introduction of intensive fish culture courses by the Saskatchewan Research Council has enabled commercial operators or entrepreneurs to step into the aquaculture field. Saskatchewan Research Council implemented the first two week course in March of 1984, and the first four hatcheries were started.

Saskatchewan Hatcheries

To date Saskatchewan has five commercial trout hatcheries in operation. Two stations began in December of 1984 and a third in January of 1985. Two additional hatcheries began operation in December of 1985 and all have had fairly good success. One operator has begun year-round production. This will necessitate a constant supply of eggs to enable him to meet production contracts. The basic schedule from eggs to 4" (10 cm) trout is 140 days with a hatchery constant of 6, though one operator has been able to achieve the same growth in 120 days with a hatchery constant of 9.

Table 5 shows a typical pricing of fingerlings from a Saskatchewan hatchery. Production costs for 4" (10 cm) rainbow trout are: five cents for feed, eggs and power; five cents for labor; five cents for capital investment over five years (7).

All commercial hatcheries in Saskatchewan have certified facilities and have had very good inspection reports. Three operators held

1984 RAINBOW TROUT PRICE LIST

SIZE	3"	3.5"	4"	4.5"	5"
No.per lb.	86	49	37	25	17
Number of Fish					
0-500	19.5	23	26	29.5	39.5
501-1000	19	22	25.5	29	38.5
1001-3000	18	21	25	28.5	38
3001-up	17.5	20.5	24.5	27.5	37.5

Price is in cents per fish.
Data from TAKARA TROUT HATCHERY 1984.

Table 5

trout over the 1985 summer in tanks. One operator had a phenomenal growth of 2" (5 cm) per month at 17°C. He started with 3" (7.6 cm) fingerlings on June 1st and ended with 11.2" (28.4 cm) by October 1st (8).

Table 6 indicates the Saskatchewan production history to date.

Support Industries

Spin-off industries have started to emerge in Saskatchewan for aquaculture. There are now off-the-shelf rearing tanks, filter enclosures, water quality testing equipment, gas tensionometers, feeders (both mechanical and demand), cages, and pumps available. The Saskatchewan Research Council is presently developing a brood stock program for rainbow trout.

Arctic char and Pacific salmon (Cohoe and Chinook) are possible new products of recirculating hatcheries in Saskatchewan. There are endless opportunities for Western Canadian Aquaculture considering the vast fresh water resources and the determination of those who wish to make it a competitive industry.

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SASKATCHEWAN IMPORT OF FINGERLINGS
VERSUS IN - PROVINCE HATCHERY
PRODUCTION 1980-85

YEAR	1980	1981	1982	1983	1984	1985
FINGERLING IMPORTS	650 K	580K	700K	745K	538K	456K
EGGS IMPORTED	48K	100K	110K		60K	663K *
FINGERLINGS PRODUCED	28K	50K	92K		48K	229K

ESTIMATED
1986 EGGS
IMPORTED -1.4 million

* - Includes some of 1986 production.
Most imports are from U.S. facilities.(Data from Saskatchewan Parks and Renewable Resources)

Table 6

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